Appendix 9.2

Modeling Protocol Used to Determine Subject-to-BART Sources

Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Kansas

Final
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I. Introduction

On July 6, 2005, the U.S. Environmental Protection Agency (EPA) published final amendments to its 1999 Regional Haze Rule in the Federal Register, including Appendix Y, the final guidance for Best Available Retrofit Technology (BART) determinations (70 FR 39104-39172). The BART rule requires the installation of BART on emission sources that fit specific criteria and "may reasonably be anticipated to cause or contribute" to visibility impairment in any Class I area. Air quality modeling is a means for determining who causes or contributes to visibility impairment. Kansas's proposed protocol for conducting this modeling for BART is provided herein.

The Kansas Department of Health and Environment (KDHE) foresees three purposes for this protocol. First, KDHE will use the protocol to determine what BART-eligible units are subject to BART and must perform a BART analysis. Second, facilities that KDHE notifies are subject to BART will have this protocol to use as a starting point to conduct modeling required when making a BART analyses. Third, KDHE will use this protocol, with potential revisions that would incorporate meteorological observations, to conduct modeling to show visibility impact on Class I areas, once KDHE approves the BART emission limits for facilities subject to BART. This final modeling will be submitted to the EPA as part of the BART section of the Kansas State Implementation Plan (SIP) for regional haze.

New BART guidance, both informal and formal, continues to become available from EPA and the Federal Land Managers (FLMs) that oversee visibility in Class I areas. Kansas has developed a schedule for completing BART analyses and implementing the BART strategy in order to meet SIP deadlines. If the state is to meet those deadlines, modeling to determine sources subject to BART and modeling to make BART analyses may need to be done before all new BART guidance from EPA and the FLMs becomes available. KDHE intends to start modeling to determine sources subject to BART in early April 2006. KDHE will use the draft version of the protocol, which will become final when approved by EPA and the FLMs. KDHE anticipates that it will notify sources subject to BART by the end of May 2006. In the BART determination guidance provided by KDHE, facilities subject to BART will be directed to the final modeling protocol for making BART analyses.

II. Background

Generally, Class I areas are national parks and wilderness areas in which visibility is more stringently protected under the Clean Air Act than any other areas in the United States. The Class I areas are shown in Appendix A.

Best Available Retrofit Technology (BART) means an emission limitation based on the degree of reduction achievable through the application of the best system of continuous emission reduction for each pollutant which is emitted by a BART-eligible source. The emission limitation must be established on a unit-by-unit basis, taking into consideration the technology available, the costs of compliance, the energy and non-air quality environmental impacts of compliance, any pollution control equipment in use or in existence at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology. BART requirements, in the form of an agreement to implement BART controls, are a part of the SIP that will be submitted to EPA in late 2007. The SIP is a comprehensive plan of action to increase visibility in the Class I areas, and includes reasonable progress goals in addition to the goals established by sources subject to BART. SIPs are subject to approval by the EPA.

The BART provisions are a part of the overall plan that focuses on reducing emissions from large sources that, due to age, were exempted from other control requirements in the Clean Air Act. An emissions source is considered eligible for BART if it:

- Falls into one of 26 listed categories (essentially the same source categories as those subject to prevention of significant deterioration or PSD, 40 CFR §§52.21 and 51.166);
- Has the potential to emit at least 250 tons per year of any haze-forming pollutant (primarily NO_x, SO_2, or PM_{10}); and
- Existed on August 7, 1977, yet was not in operation before August 7, 1962.

Thus, the BART provisions do not cover all sources that may cause or contribute to visibility impairment in any Class I area.

According to the BART guidance, an individual source is considered to cause visibility impairment if it has a least a 1.0 deciview (dv) impact on the visibility in a Class I area. A source is considered to contribute to visibility impairment if it has at least a 0.5 dv impact.

The BART guidance allows a state to exempt individual sources from the BART requirements if they do not cause or contribute to any impairment of visibility in a Class I area. Exemption is done through air quality modeling. Although the BART guidance does not dictate how such an analysis must be done, it provides direction, which was used to develop this modeling protocol.

The BART analysis process includes several other steps in addition to the modeling described in this protocol. These steps, none of which are addressed in this document, include detailed analysis of:

- Costs of compliance among the various retrofit control options;
- Energy and non-air quality impacts;
- Existing pollution control technologies in use at the BART-eligible unit, particularly with respect to their affecting the choice of retrofit options;
- Remaining useful life of the units and/or facility; and
- Improvements in visibility expected from the use of BART controls.

III. BART Air Quality Modeling Approach

One of the air quality modeling approaches suggested by EPA in the BART guidance is an individual source attribution approach. This is the approach Kansas proposes to take. Specifically, this entails modeling source-specific units and comparing modeled impacts to a particular deciview threshold (described above). Kansas has decided to conduct the subject-to-BART modeling, rather than have each BART-eligible facility either conduct the modeling or hire a contractor. This plan will eliminate the need for the State to quickly review many air quality modeling analyses conducted using varying approaches. This plan will also satisfy the need to use a consistent approach among the modeling analyses. Once the subject-to-BART modeling is complete, all the modeling inputs will be available to facilities subject to BART for them or their consultants to conduct modeling for making BART analyses.

The modeling approach discussed here is specifically designed for conducting the subject-to-BART screening analyses. There may be differences between modeling for conducting BART analyses and that for conducting a visibility analysis for a New Source Review permit, which may involve similar emission sources and the same air dispersion model used here.

In preparing this modeling protocol, KDHE consulted BART modeling protocols drafted by other organizations to attain consistency. The four available BART modeling protocols consulted were:

1. "Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Minnesota," draft version February 24, 2006;
2. "Single Source Modeling to Support Regional Haze BART," version 3, protocol developed by the Lake Michigan Air Directors Consortium (LADCO), draft version September 6, 2005;
3. "CALPUFF Modeling Protocol in Support of Best Available Retrofit Technology Determinations," developed by the State of Iowa, draft version August 2005; and
4. "Protocol for BART-Related Visibility Impairment Modeling Analyses in North Dakota," developed by the State of North Dakota, draft version September 2005.

This draft protocol is most similar to the Minnesota draft protocol. Kansas is in EPA region VII, and they will be reviewing Kansas's Regional Haze SIP, of which BART will be a part.

KDHE intends to take several steps to complete the BART air quality modeling:

1. Send a survey request form to certain facilities in Kansas and, from the response, determine the sources in Kansas that fit the criteria for eligibility (completed 2003);
2. Extract the physical characteristics of the BART-eligible units from the survey responses (completed 2005);
3. Determine which Class I areas to assess (completed 2005);
4. Choose an appropriate air quality model and develop inputs (completed 2006);
5. Conduct and post-process the subject-to-BART modeling and evaluate the results
6. Notify facilities of the screening results;

7. Obtain emission limits and stack parameters resulting from BART analyses made by facilities subject to BART; and
8. Conduct follow-up modeling showing the difference between pre- and post-BART analyses.

IV. BART-Eligible Units

In September 2002, KDHE mailed surveys to facilities that met the Regional Haze Rule's source category criteria under a request for information (RFI) about the air emission units at their facilities. Subsequent analysis of the responses to that request indicated there are 19 facilities in Kansas with BART-eligible units. The results are summarized in Table 1; detailed information on the BART-eligible units based on their response to the RFI is provided in Appendix B. These are the sources that will undergo air quality modeling to determine whether they must undergo an engineering analysis and possibly install BART controls. Figure 1 shows the names and locations of facilities with BART-eligible units in Kansas.

Figure 1. BART-Eligible Facilities in Kansas

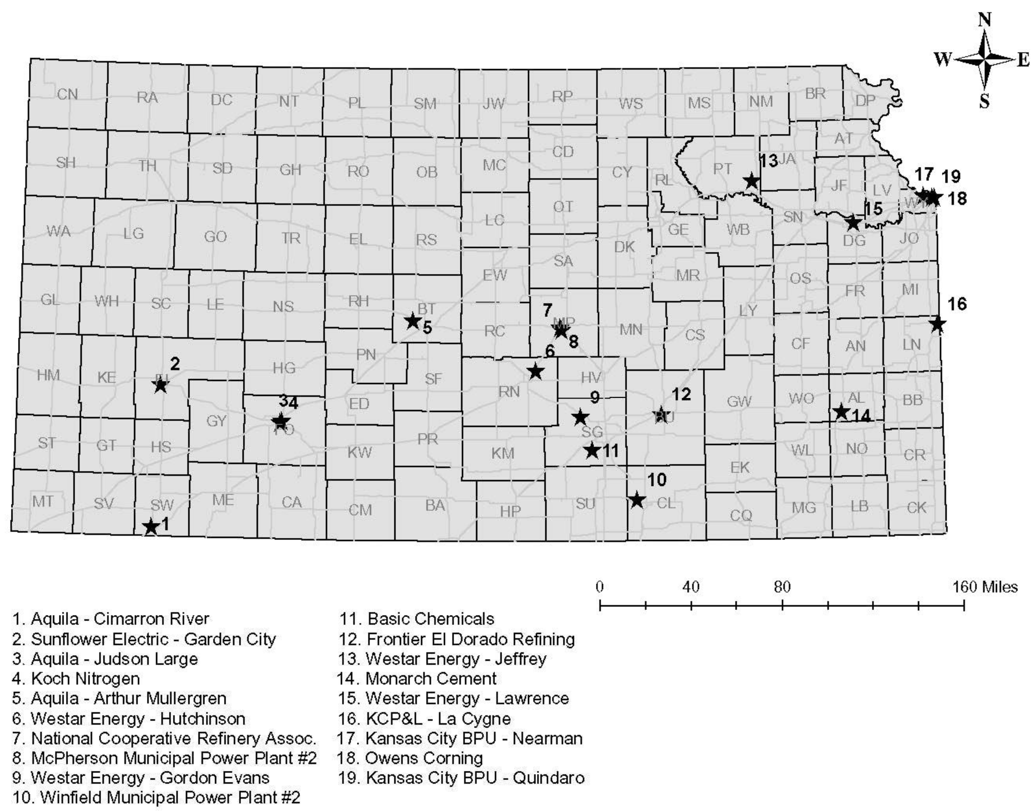


Table 1. Facilities with BART-Eligible Units

Facility	Source ID	Location - City	Nearest Class I Area (Distance)	BART-Eligible Unit(s)
Aquila - Arthur Mullergren	0090002	Great Bend	Wichita Mountains (408 km)	Unit 3 (stack 1) - 1041 MMBtu/hr; Unit 3 (stack 2) - 1041 MMBtu/hr
Aquila - Cimarron River	1750001	Liberal	Wichita Mountains (327 km)	Unit 1 - 703 MMBtu/hr
Aquila - Judson Large	0570001	Dodge City	Wichita Mountains (352 km)	Unit 4 - 1536 MMBtu/hr
Basic Chemicals	1730070	Wichita	Wichita Mountains (337 km)	Boiler 1; Boiler 2; Boiler 3; Chloromethanes
Frontier El Dorado Refining Co.	150004	El Dorado	Hercules-Glades (374 km)	Boiler B-105 - 361 MMBtu/hr (part of FCCU); Boiler B-107 - 233 MMBtu/hr (part of FCCU); Plant process heaters; Refinery flare system B-1303; Plant cooling towers; Storage tanks; Gas oil hydrotreater (Gofiner) unit fugitives; HF alkylation unit fugitives; Kerosene hydrotreater fugitives; Aromatics recovery unit fugitives; Reformate splitter unit fugitives; Cumene unit fugitives; Elemental sulfur production units; Gasoline in-line blender and field piping fugitives; Gas liquids unit fugitives
Kansas City BPU - Nearman	2090008	Kansas City	Hercules-Glades (323 km)	Unit 1 - 2433 MMBtu/hr
Kansas City BPU - Quindaro	2090048	Kansas City	Hercules-Glades (319 km)	Unit 1 - 783 MMBtu/hr; Unit 2 - 1394 MMBtu/hr
KCP&L - La Cygne	1070005	La Cygne	Hercules-Glades (244 km)	Unit 1 - 8720 MMBtu/hr; Unit 2 - 10,100 MMBtu/hr
Koch Nitrogen	0570003	Dodge City	Wichita Mountains (351 km)	Ammonia plant - primary reformer; Ammonia plant - other; Nitric acid plant - absorber tail gas; Ammonium nitrate plant - neutralizer
McPherson Municipal Power Plant #2	1130014	McPherson	Wichita Mountains (413 km)	Unit 1 - 325 MMBtu/hr

Monarch Cement Co.	0010009	Humboldt	Hercules-Glades (258 km)	No. 4 kiln stack; No. 4 kiln clinker cooler; No. 5 kiln stack; No. 5 kiln clinker cooler; Raw material unloading; Clinker grinding and cement handling; Stone quarry processing
National Cooperative Refinery Assoc.	1130003	McPherson	Wichita Mountains (412 km)	EU-ALK-3 alky heater HA-002; EU-BH-3 No. 9 boiler SB-009; EU-BH-4 No. 12 boiler SB-012; EU-FPU-11 coker IR Comp. CR-003; EU-PLT-8 plat stab boil htr. HP-003; EU-PLT-9 plat charge htr. HP-006; Fugitive emissions - all sources
Owens Corning	2090010	Kansas City	Hercules-Glades (318 km)	70 furnace - N exhaust; 70 furnace - S exhaust; 70 riser/channel/forehearth; 70 A forming; 70 B forming; 70 C forming; 70 D forming; 70 curing oven charge end; 70 curing oven discharge end; J5 furnace; J5 riser/channel/forehearth; J6 A forming; J6 B forming; J6 C forming; J6 curing oven charge end; J6 curing oven discharge end; J6 smoke stripper; J6 north cooling (A); J6 south cooling (B); J6 asphalt coating; Raw material processing
Sunflower Electric - Garden City	0550026	Garden City	Great Sand Dunes (408 km)	Unit S2 - 958 MMBtu/hr
Westar Energy - Gordon Evans	1730012	Colwich	Wichita Mountains (356 km)	Unit 2 - 4110 MMBtu/hr (stack 2); Unit 2 - 4110 MMBtu/hr (stack 3)
Westar Energy - Hutchinson	1550033	Hutchinson	Wichita Mountains (380 km)	Unit 4 - 2165 MMBtu/hr (stack A); Unit 4 - 2165 MMBtu/hr (stack B)
Westar Energy - Jeffrey	1490001	St. Marys	Hercules-Glades (408 km)	Unit 1 - 8110 MMBtu/hr; Unit 2 - 8110 MMBtu/hr
Westar Energy - Lawrence	0450014	Lawrence	Hercules-Glades (337 km)	Unit 5 - 4318 MMBtu/hr
Winfield Municipal Power Plant #2	0350012	Winfield	Wichita Mountains (317 km)	Unit 4 - 333 MMBtu/hr

V. Physical Characteristics of BART-Eligible Units

A. Emissions

Air emissions data for determining BART eligibility was obtained from facilities through the RFI described above. KDHE requested that the facilities submit emission data for nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter up to 10 µm in size (PM_{10}), volatile organic chemicals (VOCs), and ammonia (NH_3). Emissions were reported in tons per year, and reflected the potential to emit for each pollutant, in accordance with the 1999 Regional Haze Rule's definition of BART-eligible units. Subsequent to the 2005 Regional Haze Rule and the modeling guidance contained in it, further information regarding the maximum 24-hour actual emissions was requested for each BART-eligible unit. This latter emissions data will be used to model peak 24-hour averages for evaluating visibility.

KDHE does not intend to use emissions of VOCs and ammonia from facilities for subject-to-BART analysis. Only specific VOC compounds form secondary organic aerosols that affect visibility. These compounds are a fraction of the total VOCs reported in the emissions inventory, and KDHE does not have the breakdown of VOC emissions necessary to model those that only impair visibility. Further, the prescribed screening model (CALPUFF) cannot simulate formation of particles from anthropogenic VOCs, nor their visibility impacts. Ammonia from specific sources will not be evaluated in this process, although ammonia is included in the modeling as a background concentration—this will be discussed later in this modeling protocol. The appropriate VOCs and ammonia emission data can, and will be, included in regional scale modeling used for the Regional Haze SIP.

B. Stack parameters

Stack parameters for modeling were obtained from the State's emission inventory database. The parameters are: height of the stack opening from ground, inside stack diameter, exit gas flow rate, exit gas temperature, base elevation above sea level, and location coordinates of the stack. Because the modeling conducted for BART is concerned with long-range transport, not localized impacts, the RFI did not include data about building heights and widths that are used to calculate downwash. Details on the stack parameters to be used as inputs in the modeling are provided in Appendix B.

VI. Class I Areas to Assess.

There are no Mandatory Federal Class I areas located in the state of Kansas. The closest Class I areas to potential Kansas BART sources are the Wichita Mountains in Oklahoma and Hercules-Glades Wilderness Area in Missouri. These two Class I areas will be the focus of the BART visibility analysis for most Kansas sources. Impact to other surrounding Class I areas will also be evaluated. The list of nine Class I areas which will be included in the modeling analysis are depicted in Table 2. Table 2a lists the calculated distances, in kilometers, between the 19 BART-eligible sources and nine Class I areas that will be evaluated. Figure 2 shows the location of each Class I area to be evaluated.

Table 2. Class I Areas Evaluated for BART

Class I Area	State	Name
Badlands National Park	SD	BADL1
Caney Creek Wilderness Area	AR	CACR1
Great Sand Dunes National Park and Preserve	CO	GRSA1
Hercules-Glades Wilderness Area	MO	HEGL1
Mingo Wilderness Area	MO	MING1
Rocky Mountain National Park	CO	ROMO1
Upper Buffalo Wilderness Area	AR	UPBU1
Wichita Mountains Wilderness Area	OK	WIMO1
Wind Cave National Park	SD	WICA1

Figure 2. Location of Class I Areas Assessed

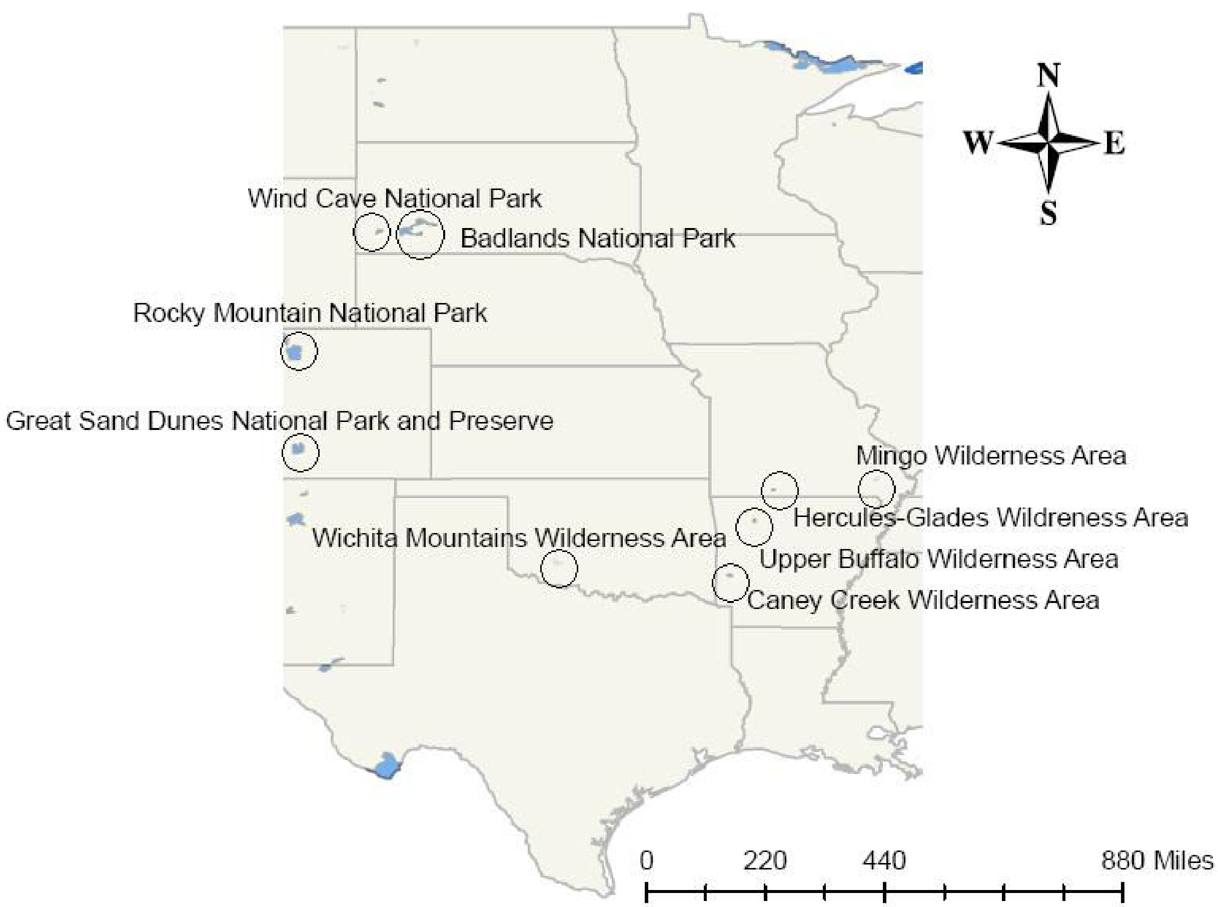


Table 2a Calculated Distances from facilities to Class I areas being evaluated

		CALCULATED DISTANCES TO CLASS I AREAS (km)								
Fac. ID	**Facility Name**	**BADL1**	**CACR1**	**GRSA1**	**HEGL1**	**MING1**	**ROMO1**	**UPBU1**	**WIMO1**	**WICA1**
0090002	Aquila – Arthur Mullergren	646	610	588	562	786	616	579	**408**	691
1750001	Aquila - Cimarron River	747	678	413	716	960	545	706	**327**	753
0570001	Aquila - Judson Large	687	635	494	633	869	568	636	**352**	712
1730070	Basic Chemicals	783	456	714	414	649	770	425	**337**	838
0150004	Frontier El Dorado Refining.	786	445	762	**374**	602	804	394	379	849
2090008	Kansas City BPU - Nearman	790	524	957	**323**	468	939	393	607	882
2090048	Kansas City BPU - Quindaro	795	523	962	**319**	463	945	390	610	887
1070005	KCP&L - La Cygne	859	433	958	**244**	263	968	306	542	943
0570003	Koch Nitrogen	688	636	493	634	424	568	637	**351**	712
1130014	McPherson Mun. Power Plant #2	696	537	691	464	683	714	488	**413**	755
0010009	Monarch Cement Co.	859	389	889	**258**	477	922	295	451	934
1130003	National Coop. Refinery Assoc.	698	535	692	462	681	716	486	**412**	758
2090010	Owens Corning	797	522	964	**318**	461	947	389	611	888
0550026	Sunflower Electric - Garden City	647	721	**408**	722	957	483	725	409	658
1730012	Westar Energy - Gordon Evans	759	479	705	428	659	752	443	**356**	815
1550033	Westar Energy - Hutchinson	715	524	673	468	694	710	486	**380**	*770*
1490001	Westar Energy - Jeffrey	694	564	838	**408**	582	818	462	556	778
0450014	Westar Energy - Lawrence	766	515	905	**337**	504	894	398	564	853
0350012	Winfield Mun. Power Plant #2	829	409	748	377	616	813	381	**317**	885

VII. Air Quality Model and Inputs

According to the final Regional Haze Rule's BART guidance, a State "can use CALPUFF or other appropriate model to predict the visibility impacts from a single source at a Class I area." For purposes of the BART analysis, KDHE intends to use CALPUFF. The KDHE recognizes that CALPUFF has limited ability to simulate the complex atmospheric chemistry involved in the estimation of secondary particulate formation. However, for purposes of the subject-to-BART analysis, KDHE intends to use CALPUFF for the following reasons:

1. The increased level of effort required for conducting particulate apportionment in the regional scale, full-chemistry Eulerian model (CAMx) to acquire individual source contributions to Class I areas, relative to the simplicity of the CALPUFF model;
2. The lack of a plume-in-grid feature with the particulate apportionment technique currently available in CAMx;
3. The desire to be consistent with other CENRAP states, which all (except Texas and Iowa) appear to be using CALPUFF;
4. The limited scope of what this modeling is to determine; and
5. The additional modeling of BART controls that will be conducted as part of the Regional Haze SIP with the CAMx or CMAQ model(s). EPA's BART guidance states that States should follow the EPA's Interagency Workgroup on Air Quality Modeling (IWAQM) guidance, Phase 2 recommendations for long-range transport. The IWAQM guidance was developed to address air quality impacts as assessed through the Prevention of Significant Deterioration (PSD) program at Class I areas, where the source generally is located beyond 50 km of the Class I area. The IWAQM guidance does not specifically address the type of assessment that will occur with the BART analysis.

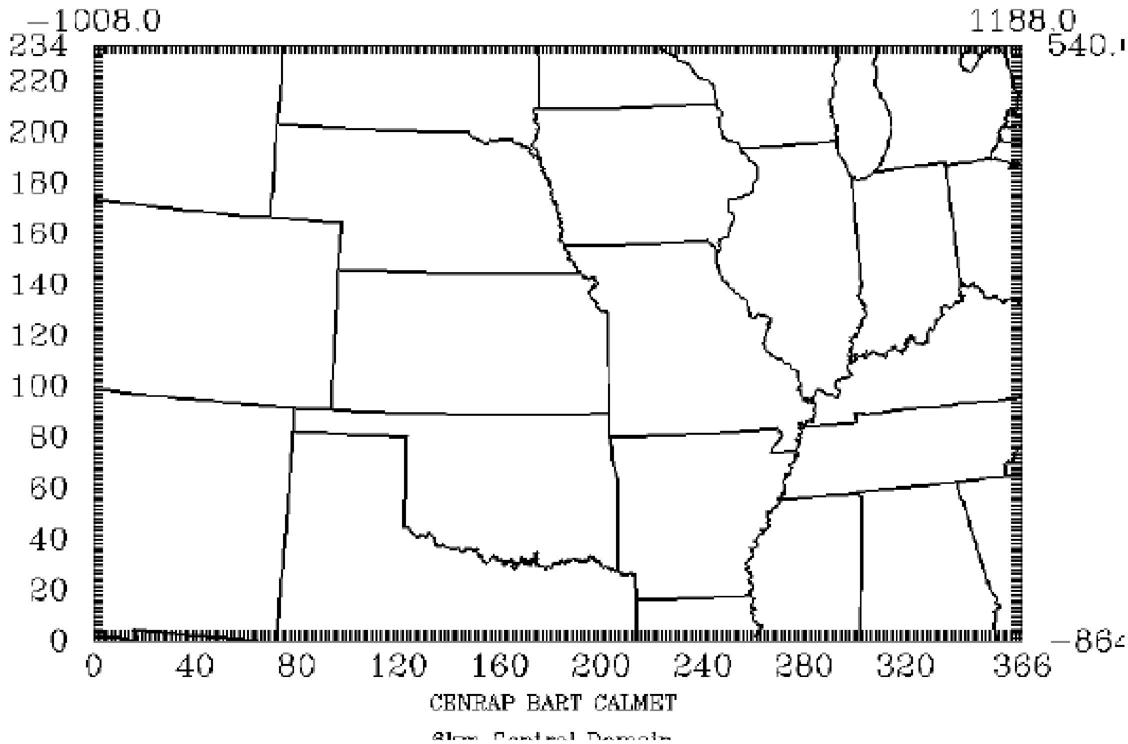
CALPUFF Modeling

CALPUFF modeling will be performed on all Kansas BART-eligible sources. KDHE intends to closely follow the CENRAP CALPUFF modeling protocol for most of the settings and inputs. It is important to note that the majority of potential Kansas BART sources are beyond 250 km to the nearest Class I area. The use of puff splitting in the initial screening modeling was attempted, but found computationally prohibitive on the current domain; thus puff splitting will not be employed is this modeling.

A. Modeling domain

The CALPUFF modeling will be conducted on the CENRAP central 6 km grid. The extent of the proposed CALPUFF domain is shown in Figure 2.

Figure 2. 6 km CENRAP Central CALPUFF Domain



CALPUFF will be applied to each source for three annual simulations spanning the years 2001 through 2003. The IWAQM guidance allows the use of fewer than 5 years of meteorological data if a meteorological model using four-dimensional data assimilation is used to supply data. This is the case in this modeling analysis. See the section on meteorology for more information.

B. CALPUFF system implementation

There are three main components to the CALPUFF model:

1. Meteorological Data Modeling (CALMET);
2. Dispersion Modeling (CALPUFF); and
3. Postprocessing (CALPOST)

Versions of the modeling components to use in this BART analysis are shown in Table 3, which follows.

Table 3. CALPUFF Modeling Components

Processor	Version	Level
TERREL	3.311	030709
CTGCOMP	2.42	030709
CTGPROC	2.42	030709
MAKEGEO	2.22	030709
CALMM5	2.4	050413
CALMET	5.53a	040716
CALPUFF	5.753	051130
POSTUTIL	1.4	040818
CALPOST	5.6392	051130

The specific use of each of these components in the BART analysis is described in more detail below.

Because the KDHE is proposing to use a later version of the CALPUFF system rather than the EPA approved regulatory version, we have performed a test run with both systems to ensure identical results between the two systems. This analysis can be found in Appendix E. The results indicate that the proposed version of CALPUFF gives identical results as the regulatory version.

C. Meteorological data modeling (CALMET)

KDHE will use the 2001-2003 CENRAP-developed CALMET dataset for its modeling. For additional information on the settings used to develop this dataset, refer to the CENRAP BART Modeling Guidelines document in Appendix C.

Note that no observation data was used in the CALMET outputs developed by CENRAP. This means the prognostic meteorological data set from MM5 is not supplemented with surface or upper air observations during the CALMET processing. The use of observations is thought to counterbalance smoothing that may occur when using the coarse grid scale of the MM5 data. Both the EPA and FLMs commented on the draft CENRAP guidelines that observations should be used in refined CALPUFF modeling. KDHE is recommending that observations be incorporated into a refined modeling analysis, but not in this screening analysis.

Appendix C contains the CENRAP BART Modeling Guidelines, which discuss the full suite of settings used to generate the CALMET data.

D. Dispersion modeling (CALPUFF)

The CALMET output is used as input to the CALPUFF model, which simulates the effects of the meteorological conditions on the transport and dispersion of pollutants from an individual source. In general, KDHE proposes to use the recommended default options in the CALPUFF model. There are some deviations, which are discussed below. CALPUFF is considered most applicable for sources located between 50 km and 250 km of the Class I area; in Kansas, the majority of BART-eligible units are beyond 250 km. The CALPUFF model has a puff-splitting option that splits puffs that become large over greater transport distances. KDHE does not initially intend to invoke puff-splitting for these more distant sources, due to excessive computational run times. However, KDHE proposes to use puff-splitting when performing more refined modeling on a smaller grid. The following species will be modeled and/or emitted in this BART analysis:

Table 4. Species Modeled in BART Analysis

Species	Modeled	Emitted	Dry Deposited
SO_2	Yes	Yes	Computed-gas
SO_4	Yes	No	Computed-particle
NO_x	Yes	Yes	Computed-gas
HNO_3	Yes	No	Computed-gas
NO_3	Yes	No	Computed-particle
PM-fine	Yes	Yes	Computed-particle
PM-coarse	Yes	Yes	Computed-particle

Note that in the case of a source where the PM profile for sulfate (SO_4), elemental carbon (EC), and secondary organic aerosols (SOA) are known, SO_4 will be modeled as a separate species in CALPUFF if that source is close to the visibility contribution threshold. This will not be necessary in most cases, as many sources will be either clearly impacting or clearly not impacting a Class I area, and in many cases the PM profile will not be known.

Particle size parameters are entered in the CALPUFF input file for dry deposition of particles. There are default values for "aerosol" species (i.e., SO_4, NO_3, and $PM_{2.5}$). The default value for each of these species is 0.48 µm geometric mass mean diameter and 2.0 µm geometric standard deviation. Where the facility is able to supply emissions of $PM_{2.5}$, the default values may be appropriate. However, many facilities may not be able to supply $PM_{2.5}$ emissions and will supply what is available, PM_{10} emissions data. In this case, using the default values may underestimate deposition of particulates and overestimate the particulate contribution to visibility. For sources that did not report $PM_{2.5}$ emissions in the RFI, KDHE intends to speciate PM_{10} emissions to $PM_{2.5}$ and PM course by using the $PM_{2.5}$/ PM_{10} ratio reported to or calculated by KDHE for the 2002 emissions inventory. The KDHE request for information described above did not request that sources indicate how much of their particulate emissions might be elemental carbon or secondary organic aerosol. The light extinction coefficient for $PM_{2.5}$ is 1, for EC is 10, and for SOA is 4. Thus, EC and SOA will have a comparatively higher impact on visiblity. The main sources of these particles are fuel combustion. A way to account for this, without including EC and SOA in the modeling, is to use particle speciation in the post-processing step. This is discussed below in the CALPOST section.

Ozone and ammonia concentrations: Ozone (O_3) and ammonia (NH_3) can be input to CALPUFF as hourly or monthly background values. Hourly values of ozone concentrations were obtained from three rural monitoring sites in Kansas, Peck, Mine Creek, and Cedar Bluff monitors. These hourly ozone values will be used in this modeling. Background ammonia concentration is assumed to be temporally and spatially invariant and will be fixed at 3 ppb across the entire domain for all months. It may be possible to derive NH_3 concentrations from regional modeling outputs that CENRAP is currently developing. At this time these NH_3 values are not available in a model ready form.

Receptors: Receptors are locations where model results are calculated and provided in the CALPUFF output files. Receptor locations were derived from the National Park Service's Class I area receptor database at http://www2.nature.nps.gov/air/maps/receptors/index.cfm. Only these discrete NPS receptors will be modeled in CALPUFF. The discrete receptors are necessary for calculating visibility impacts in the nine selected Class I areas that will be evaluated by KDHE. All the discrete receptors will be placed with enough density that the highest visibility impacts should be evident. The NPS provides receptors in all the Class I areas on a 1 km basis. These receptors will be kept at the 1 km spacing for the BART modeling, and all receptors will be retained.

Outputs: The CALPUFF modeling results will be displayed in units of micrograms per cubic meter ($\mu g/m^3$). In order to determine visibility impacts, the CALPUFF outputs must be post-processed.

Detailed information on all CALPUFF setting to be used in this screening can be found in Appendix D.

E. Post-processing (CALPOST)

Hourly concentration outputs from CALPUFF are processed through POSTUTIL and CALPOST to determine visibility conditions. Specifically, POSTUTIL takes the concentration file output from CALPUFF and recalculates the nitric acid and nitrate partition based on total available sulfate and ammonia. CALPOST uses the concentration file processed through POSTUTIL, along with relative humidity data, to perform visibility calculations. For the BART analysis, the only modeling results out of the CALPUFF modeling system of interest are the visibility impacts. Please see Appendix E and F for detailed settings for POSTUTIL and CALPOST.

Light extinction: Light extinction must be computed in order to calculate visibility. CALPOST has seven methods for computing light extinction. This BART screening analysis will use Method 6, which computes extinction from speciated particulate matter with monthly Class I area-specific relative humidity adjustment factors, and is implied by the BART guidance. Relative humidity is an important factor in determining light extinction (and therefore visibility) because sulfate and nitrate aerosols, which absorb moisture from the air, have greater extinction efficiencies with greater relative humidity. This BART analysis will apply relative humidity correction factors (*f*(RH)s) to sulfate and nitrate concentrations outputs from CALPUFF, which were obtained from EPA's "Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule (EPA, 2003). The *f*(RH) values for the Class I areas that will be assessed are provided in Table 5.

Table 5. Monthly Averaged *f*(RH) Based on Centroid of the Class I Area

Class I Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Badlands	2.6	2.7	2.6	2.4	2.8	2.7	2.5	2.4	2.2	2.3	2.7	2.7
Caney Creek	3.4	3.1	2.9	3.0	3.6	3.6	3.4	3.4	3.6	3.5	3.4	3.5
Great Sand Dunes	2.4	2.3	2.0	1.9	1.9	1.8	1.9	2.3	2.2	1.9	2.4	2.4
Hercules-Glades	3.2	2.9	2.7	2.7	3.3	3.3	3.3	3.3	3.4	3.1	3.1	3.3
Mingo	3.3	3.0	2.8	2.6	3.0	3.2	3.3	3.5	3.5	3.1	3.1	3.3
Rocky Mountain	1.7	1.9	1.9	2.1	2.3	2.0	1.8	2.0	1.9	1.8	1.8	1.7
Upper Buffalo	3.3	3.0	2.7	2.8	3.4	3.4	3.4	3.4	3.6	3.3	3.2	3.3
Wichita Mountains	2.7	2.6	2.4	2.4	3.0	2.7	2.3	2.5	2.9	2.6	2.7	2.8
Wind Cave	2.5	2.5	2.5	2.5	2.7	2.5	2.3	2.3	2.2	2.2	2.6	2.6

The $PM_{2.5}$ concentrations are considered part of the dry light extinction equation and do not have a humidity adjustment factor. The light extinction equation is the sum of the wet sulfate and nitrate and dry components $PM_{2.5}$ plus Rayleigh scattering, which is 10 inverse megameters (Mm^{-1}).

To account for sources modeled with a known PM speciation profile for EC, SOA, and SO_4, an adjustment to the extinction coefficient for the PM components will be made in CALPOST. KDHE intends to follow the method outlined in the FLM CALPUFF Reviewer's Guide.

VIII. Visibility Impacts

Perceived visibility in deciviews is derived from the light extinction coefficient. The visibility change related to background is calculated using the modeled and established natural visibility conditions. For this BART analysis, daily visibility will be expressed as a change in deciviews compared to natural visibility conditions.

The annual average natural levels of aerosol components at each Class I area are shown in Table 6. Natural conditions by component in this Table are based on whether the Class I area is in the eastern or the western part of the United States. In this BART analysis, some Class I areas are located in the East and some in the West. This data is in EPA's "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule (EPA, 2003).

Table 6 - Average Annual Natural Levels of Aerosol Components ($\mu g/m^3$)

Class I Area	Region	SO_4	NO_3	OC	EC	Soil	Coarse Mass
Badlands	WEST	0.12	0.10	0.47	0.02	0.50	3.00
Caney Creek	EAST	0.23	0.10	1.40	0.02	0.50	3.00
Great Sand Dunes	WEST	0.12	0.10	0.47	0.02	0.50	3.00
Hercules-Glades	EAST	0.23	0.10	1.40	0.02	0.50	3.00
Mingo	EAST	0.23	0.10	1.40	0.02	0.50	3.00
Rocky Mountain	WEST	0.12	0.10	0.47	0.02	0.50	3.00
Upper Buffalo	EAST	0.23	0.10	1.40	0.02	0.50	3.00
Wichita Mountains	WEST	0.12	0.10	0.47	0.02	0.50	3.00
Wind Cave	WEST	0.12	0.10	0.47	0.02	0.50	3.00

In a cooperative agreement with EPA Regions VI and VII and federal land managers, CENRAP guidance deviates from use of the 98^{th} percentile impact. The CALMET datasets as described in this protocol were processed with the "No-Obs" options (i.e., surface observations were not used in the CALMET wind field interpolation). Aware that exercising CALMET with No-Obs may lead in some applications to potentially less conservatism in the CALPUFF visibility results compared with the use of CALMET with observations, CENRAP has agreed to EPA's recommendation that the maximum visibility impact, rather than the 98^{th} percentile value, should be used for screening analyses using the CENRAP-developed CALMET datasets. This approach will be used in this screening analysis.

Sources with modeled maximum impacts below the 0.5 dv threshold will be exempt from the remainder of the BART process. Sources with impacts at or above 0.5 dv will be allowed a reasonable window of time, during which they can either perform more refined CALPUFF modeling to show their visibility impact is in fact below the 0.5 dv threshold, or they can modify their Title V air operating permit to reduce the potential to emit (PTE) for their BART-eligible units to below BART eligibility values for haze-forming pollutants. The remaining sources must continue with the BART process and perform a BART analysis. This analysis will likely include more refined CALPUFF modeling, using observations coupled with the 98^{th} percent impact, finer grid resolution, puff splitting, focused domain, etc.

IX. Change in Visibility Due to BART Controls

Once facilities perform their BART analysis and BART emission limits are established, KDHE will conduct additional CALPUFF modeling in order to establish visibility improvement at Class I areas with BART applied. The post-control CALPUFF simulation will be compared to the pre-control CALPUFF simulation by calculating the change in visibility over natural conditions between the pre-control and post-control simulations. As mentioned above, KDHE will make available the CALPUFF input files used for determining sources subject to BART, which facilities may use when making their own BART determination.

Upon completion of the CALPUFF screening runs, the KDHE will determine if additional technical guidance or CALMET model data is available that includes surface and upper air observations. This refined modeling, if available, will be used along with an amended protocol for performing additional CALPUFF modeling in order to establish visibility improvement at Class I areas. It is also likely that some sources will undertake and provide refined modeling that can be used for evaluating visibility improvement. These refinements would be utilized in this later modeling.

Sources performing refined modeling will be required to submit a modeling protocol to the department for approval. Protocols should also be made available concurrently to EPA and FLM's for their review. The KDHE and EPA will also be requesting modeling inputs used in the modeling process. Sources using KDHE's modeling protocol and modeling inputs will not be required to provide a full modeling protocol. The KDHE has a BART analysis guidance document to assist sources in the BART analysis process. This document is available upon request.

References

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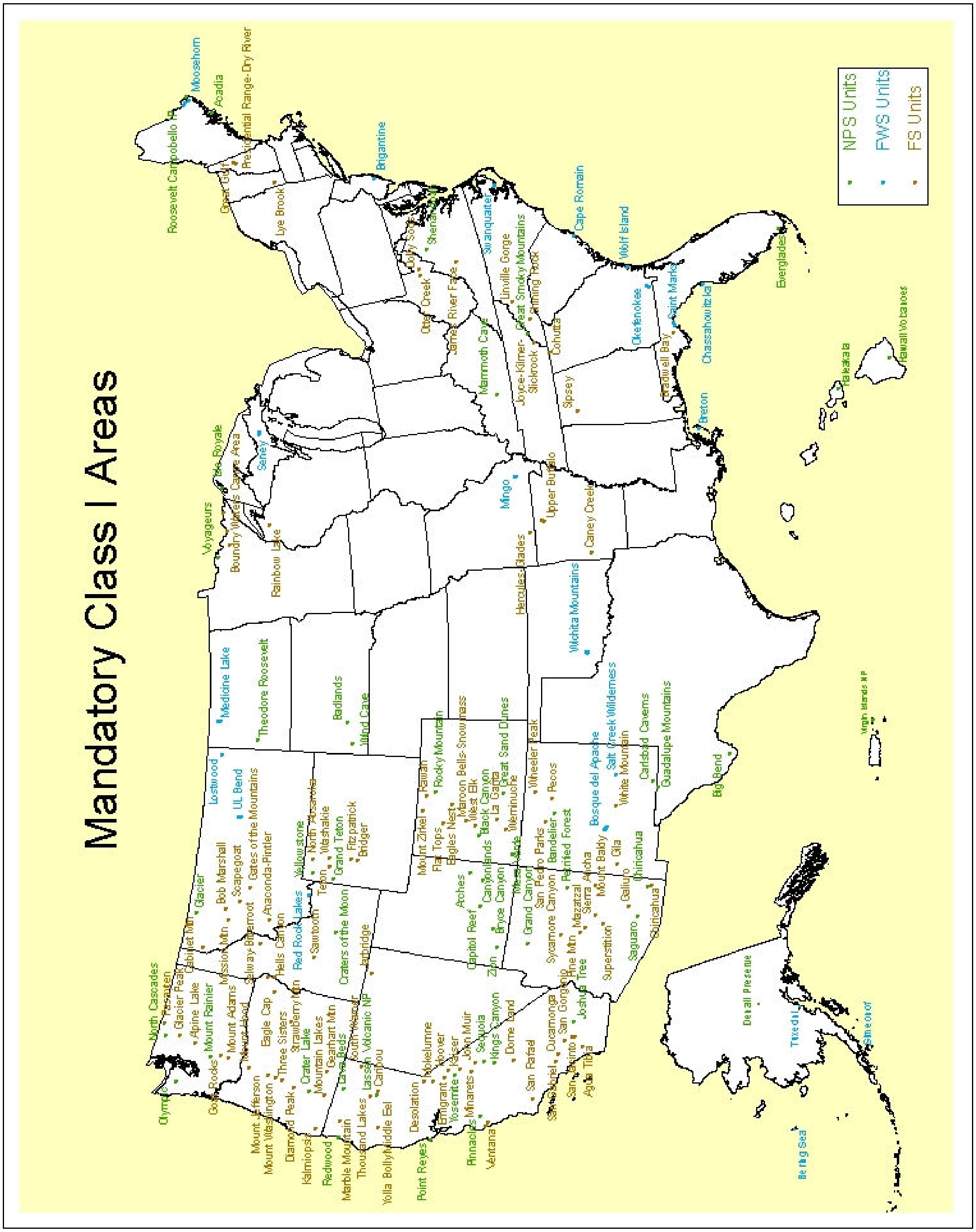
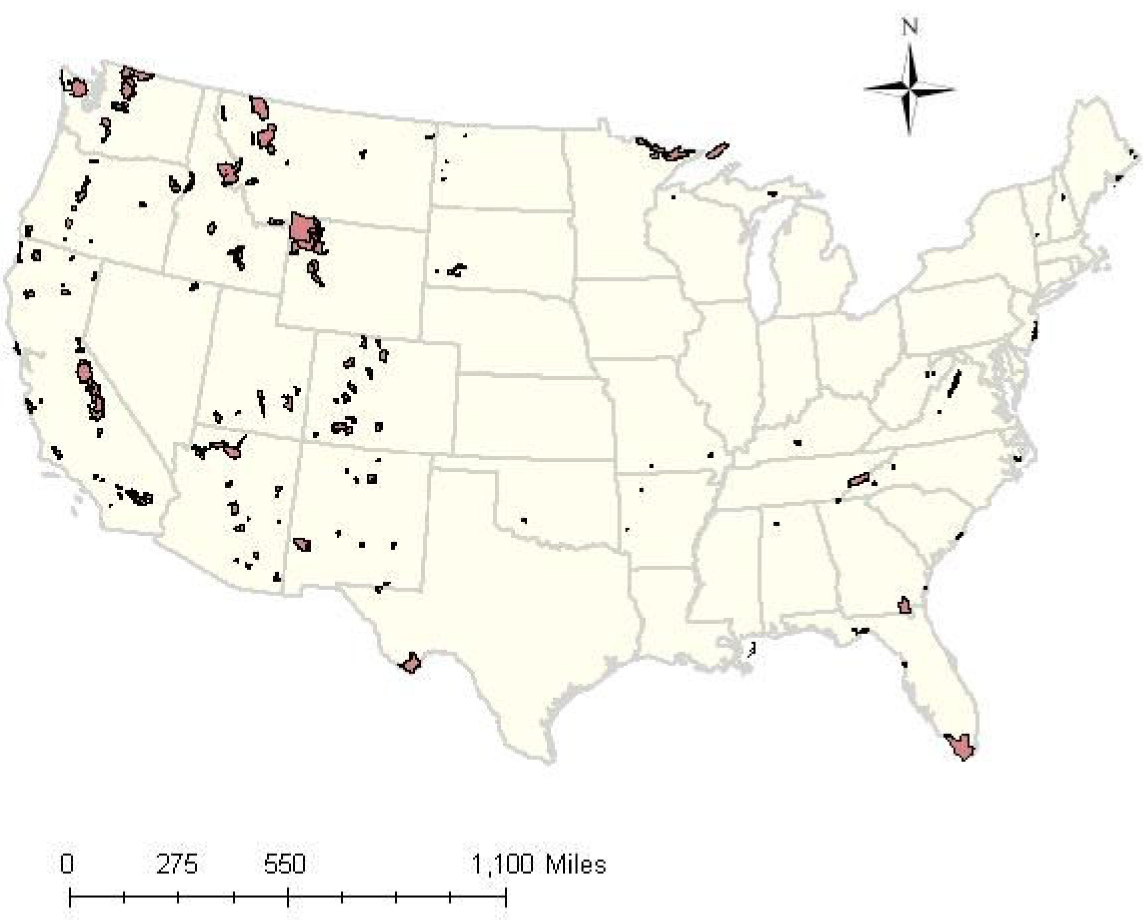
Appendix A – Federal Class I Areas

—Map showing locations and names of areas



Appendix A – Federal Class I Areas
—Map showing extent of areas

Mandatory Federal Class I Areas



Appendix B – Kansas BART-Eligible Unit Details

BART-Eligible Unit Description	Stack #	Stack Height	Stack Diameter	Gas Exit Velocity	Gas Temp.	Gas Flow Rate	Highest 24 hr Actual Emissions (ton/yr)		
		ft	ft	ft/sec	°F	acfm	SO_2	NO_x	PM_{10}
Aquila - Arthur Mullergren									
Unit 3 - 1041 MMBtu/hr (stack 1)	1	146.0	6.5	0.3	325	600	0.0	19.0	2.6
Unit 3 (stack 2)	2	146.0	6.5	0.3	350	2,075	0.0	19.0	2.6
						Totals:	0.0	38.0	5.2
Aquila - Cimarron River									
Unit 1 - 703 MMBtu/hr	1	93.0	8.0	54.5	955	164,502	0.0	28.1	3.8
Aquila - Judson Large									
Unit 4 - 1536 MMBtu/hr	1	149.0	10.7	91.0	302	492,802	0.1	84.7	9.7
Basic Chemicals									
Boiler 1	1	34.0	6.0	28.5	280	48,400	0.4	193.7	5.3
Boiler 2	2	34.0	6.0	28.5	280	48,400	0.4	193.7	5.3
Boiler 3	3	18.0	4.0	36.8	270	27,700	0.2	113.1	3.1
Chloromethanes (control not B-E)	5	59.0	1.7	23.0	95	3,000	0.0	6.4	0.0
						Totals:	1.0	506.9	13.7
Frontier El Dorado Refining Co.									
Boiler B-105 - 361 MMBtu/hr (part of FCCU)	3	131.0	6.9	68.9	601	154,120	5.1	346.8	9.5
Boiler B-107 - 233 MMBtu/hr (part of FCCU)	4	98.0	6.9	46.6	399	104,214	2.9	160.6	5.5
Plant process heaters	7	118.0	5.9	21.6	449	35,586	5.5	360.0	9.5
Refinery flare system B-1303	16	300.0	3.0	65.5	1,832	28,171	485.5	341.6	0.2
Elemental sulfur production units	18	100.0	3.9	139.1	1,200	101,609	98.6	0.4	0.3
						Totals:	597.6	1,209.4	25.0
Kansas City BPU - Nearman									
Unit 1 - 2433 MMBtu/hr	1	400.0	23.3	44.0	305	827,000	12,015.8	5,971.4	79.7

BART-Eligible Unit Description	Stack #	Stack Height	Stack Diameter	Gas Exit Velocity	Gas Temp.	Gas Flow Rate	Highest 24 hr Actual Emissions (ton/yr)		
		ft	ft	ft/sec	°F	acfm	SO_2	NO_x	PM_{10}
Kansas City BPU - Quindaro									
Unit 1 - 783 MMBtu/hr	1	350.0	12.4	39.0	330	247,100	3,511.3	3,314.2	2.8
Unit 2 - 1394 MMBtu/hr	2	350.0	13.3	83.0	326	474,500	4,482.2	1,620.6	22.0
						Totals:	7,993.5	4,934.8	24.8
KCP&L - La Cygne									
Unit 1 - 8720 MMBtu/hr	1	700.0	23.0	92.7	127	2,310,507	20,305.0	44,533.7	171.6
Unit 2 - 10,100 MMBtu/hr	2	700.0	24.0	100.8	281	2,734,697	28,758.4	13,450.3	251.9
						Totals:	49,063.4	57,984.0	423.5
Koch Nitrogen									
Ammonia plant - primary reformer	1	139.0	11.0	26.3	300	149,962	1.5	693.5	43.8
Ammonia plant - other	2	83.0	1.3	215.9	140	15,848	0.1	18.6	0.3
Nitric acid plant - absorber tail gas	3	50.0	2.4	158.0	420	43,506	0.0	65.7	0.0
Ammonium nitrate plant - neutralizer	5	33.0	1.0	81.0	198	3,818	0.0	0.0	25.8
						Totals:	1.6	777.8	69.9
McPherson Municipal Power Plant #2									
Unit 1 - 325 MMBtu/hr	4	82.0	6.4	35.0	900	76,050	0.6	297.5	2.0
Monarch Cement									
No. 4 kiln stack	3	190.0	7.0	52.8	311	122,000	21.0	1,346.2	25.3
No. 4 kiln clinker cooler	4	40.0	6.0	44.8	172	76,000	0.0	0.0	2.4
No. 5 kiln stack	5	190.0	7.0	60.2	240	139,000	21.0	1,346.2	12.6
No. 5 kiln clinker cooler	6	40.0	6.0	46.0	244	78,000	0.0	0.0	11.7
Raw material unloading	7	25.0	5.0	30.6	139	36,000	0.0	0.0	9.3
Clinker grinding and cement handling	24	90.0	1.6	26.9	175	3,250	0.0	0.0	22.1
Stone quarry processing	Fug.	10.0	13.7	14.2	56	500,000	0.0	0.0	108.1
						Totals:	42.0	2,692.4	191.5

BART-Eligible Unit Description	Stack #	Stack Height	Stack Diameter	Gas Exit Velocity	Gas Temp.	Gas Flow Rate	Highest 24 hr Actual Emissions (ton/yr)		
		ft	ft	ft/sec	°F	acfm	SO_2	NO_x	PM_{10}
National Cooperative Refinery Assoc.									
EU-ALK-3 alky heater HA-002	25	65.0	4.6	14.6	700	14,564	5.7	29.7	1.6
EU-BH-3 No. 9 boiler SB-009	26	51.0	3.9	20.6	510	14,788	4.2	22.1	1.2
EU-BH-4 No. 12 boiler SB-012	27	89.3	3.9	38.0	500	27,262	7.7	40.0	2.2
EU-FPU-11 coker IR Comp. CR-003	14	19.0	0.8	41.3	750	1,353	0.5	73.8	0.2
EU-PLT-8 plat stab boil htr. HP-003	28	70.8	3.3	11.1	600	5,704	1.9	9.8	0.5
EU-PLT-9 plat charge htr. HP-006	21	77.0	4.3	30.2	520	26,307	15.3	79.8	4.3
						Totals:	35.3	255.2	10.0
Owens Corning									
70 furnace - N exhaust	3	67.1	4.0	16.2	130	11,000	0.6	81.5	1.9
70 furnace - S exhaust	4	67.1	4.0	16.2	130	11,000	0.6	81.5	1.9
70 riser/channel/forehearth	27	60.4	16.8	9.3	110	115,000	0.1	5.5	20.4
70 A forming	5	93.4	4.3	26.3	100	22,000	5.6	2.5	22.5
70 B forming	28	100.8	4.6	23.5	100	22,000	5.6	2.5	22.5
70 C forming	6	99.4	4.0	30.8	100	22,000	5.6	2.5	2.9
70 D forming	7	93.4	4.3	26.3	100	22,000	5.6	2.5	2.9
70 curing oven charge end	8	42.3	2.5	26.4	90	7,500	0.9	1.5	2.9
70 curing oven discharge end	29	37.8	2.0	41.3	90	7,500	0.9	1.5	2.9
J5 furnace	10	101.2	3.0	54.6	450	13,500	0.9	1.2	2.0
J5 riser/channel/forehearth	11	54.6	30.3	8.7	110	350,000	0.0	6.1	11.7
J6 A forming	20	74.1	3.0	54.8	100	22,000	2.2	2.1	15.3
J6 B forming	21	100.8	4.6	23.5	100	22,000	2.2	2.1	3.1
J6 C forming	22	76.2	3.8	35.1	100	22,000	2.2	2.1	15.3
J6 curing oven charge end	23	37.8	1.8	49.1	90	7,500	0.6	1.2	1.0
J6 curing oven discharge end	24	35.6	1.8	49.1	90	7,500	0.6	1.2	1.0
J6 smoke stripper	30	42.5	1.7	39.5	90	5,000	0.0	0.0	0.1
J6 north cooling (A)	25	42.3	3.4	37.7	90	20,000	0.0	0.0	1.4
J6 south cooling (B)	26	39.0	3.4	37.7	90	20,000	0.0	0.0	1.4
J6 asphalt coating	19	38.0	2.8	17.1	80	6,000	0.0	0.0	0.1
						Totals:	34.2	197.5	133.2

BART-Eligible Unit Description	Stack #	Stack Height	Stack Diameter	Gas Exit Velocity	Gas Temp.	Gas Flow Rate	Highest 24 hr Actual Emissions (ton/yr)		
		ft	ft	ft/sec	°F	acfm	SO_2	NO_x	PM_{10}
Sunflower Electric - Garden City									
Unit S2 - 958 MMBtu/hr	2	124.0	10.0	57.0	253	266,338	2.2	1,045.1	31.3
Westar Energy - Gordon Evans									
Unit 2 - 4110 MMBtu/hr (stack 2)	2	197.0	13.0	69.0	290	569,415	9,307.5	4,398.3	372.3
Unit 2 (stack 3)	3	197.0	13.0	69.0	290	569,415	9,307.5	4,398.3	372.3
						Totals:	18,615.0	8,796.6	744.6
Westar Energy - Hutchinson									
Unit 4 - 2165 MMBtu/hr (stack A)	4	149.0	8.0	55.7	313	168,000	5,365.5	857.8	167.9
Unit 4 (stack B)	5	149.0	8.0	55.7	313	168,000	5,365.5	857.8	167.9
						Totals:	10,731.0	1,715.6	335.8
Westar Energy - Jeffrey									
Unit 1 - 8110 MMBtu/hr	1	600.0	26.0	91.3	300	2,800,000	28,543.0	15,038.0	781.1
Unit 2 - 8110 MMBtu/hr	2	600.0	26.0	91.3	300	2,800,000	29,747.5	15,074.5	784.8
						Totals:	58,290.5	30,112.5	1,565.9
Westar Energy - Lawrence									
Unit 5 - 4318 MMBtu/hr	4	366.0	18.0	36.0	166	583,814	8,358.5	4,818.0	755.6
Winfield Mun. Power Plant #2									
Unit 4 - 333 MMBtu/hr	1	160.0	5.0	195.0	545	63,800	0.7	290.5	2.3

Appendix C – CENRAP BART Modeling Guidelines

See attached zip file.

Appendix D – CALPUFF Control File Inputs

Variable	Description	Value	Default	Comments
INPUT GROUP 1: General run control parameters				
METRUN	Control parameter for running all periods in met. File (0=no; 1=yes)	0	Y	
IBYR	Starting year of the CALPUFF run	2002	n/a	2001 and 2003 are the other years modeled
IBMO	Starting month	1	n/a	
IBDY	Starting day	1	n/a	
IBHR	Starting hour	1	n/a	
XBTZ	Base time zone	6.0	n/a	Central Standard Time
IRLG	Length of the run (hours)	8760	n/a	2001=8760hrs, 2003=8748hrs only 12 hrs on 12/31
NSPEC	Total number of species modeled	7	5	
NSE	Number of species emitted	4	3	
METFM	Meteorological data format	1	Y	CALMET unformatted file
AVET	Averaging time (minutes)	60.0	Y	
PGTIME	Averaging time (minutes) for PG - σ_y	60.0	Y	
INPUT GROUP 2: Technical options				
MGAUSS	Control variable determining the vertical distribution used in the near field	1	Y	Gaussian
MCTADJ	Terrain adjustment method	3	Y	Partial plume path adjustment
MCTSG	CALPUFF sub-grid scale complex terrain module (CTSG) flag	0	Y	CTSG not modeled
MSLUG	Near-field puffs are modeled as elongated "slugs"?	0	Y	No
MTRANS	Transitional plume rise modeled?	1	Y	Transitional plume rise computed
MTIP	Stack tip downwash modeled?	1	Y	Yes
MBDW	Method used to simulate building downwash?	1	Y	ISC method
MSHEAR	Vertical wind shear above stack top modeled in plume rise?	0	Y	No
MSPLIT	Puff splitting allowed?	0	Y	No
MCHEM	Chemical mechanism flag	1	Y	Transformation rates computed internally (MESOPUFF II scheme)
MAQCHEM	Aqueous phase transformation flag	0	Y	Aqueous phase not modeled
MWET	Wet removal modeled?	1	Y	Yes
MDRY	Dry deposition modeled?	1	Y	Yes
MDISP	Method used to compute dispersion coefficients	3	Y	PG dispersion coefficients in RURAL & MP coefficients in urban areas
MTURBVW	Sigma-v/sigma-theta, sigma-w measurements used?	3	Y	Use both sigma-(v/theta) and sigma-w from PROFILE.DAT Note: not provided

Variable	Description	Value	Default	Comments
MDISP2	Backup method used to compute dispersion when measured turbulence data are missing	3	Y	PG dispersion coefficients in RURAL & MP coefficients in urban areas
MROUGH	PG sigma-y,z adj. for roughness?	0	Y	No
MPARTL	Partial plume penetration of elevated inversion?	1	Y	Yes
MTINV	Strength of temperature inversion	0	Y	No
MPDF	PDF used for dispersion under convective conditions?	0	Y	No
MSGTIBL	Sub-Grid TIBL module used for shoreline?	0	Y	No
MBCON	Boundary conditions (concentration) modeled?	0	Y	No
MFOG	Configure for FOG model output	0	Y	No
MREG	TEST options specified to see if they conform to regulatory values?	1	Y	Checks made
INPUT GROUP 3: Species list				
CSPEC	Species modeled	SO2 SO4 NOX HNO3 NO3 PM25 PM10	n/a	Modeled: All Emitted: SO2, NOx, PM25, PM10 Dry deposited: SO2(gas), SO4(particle), NOx(gas), HNO3(gas), NO3(particle), PM25(particle), PM10(particle)
INPUT GROUP 4: Map projection and grid control parameters				
PMAP	Map projection	LCC	N	Lambert conformal conic
FEAST	False Easting	0.0	Y	
FNORT	False Northing	0.0	Y	
RLATO	Latitude	40N	n/a	
RLONG	Longitude	97W	n/a	
XLAT1 XLAT2	Matching parallel(s) of latitude for projection	33N 45N	n/a n/a	
DATUM	Datum region for the coordinates	WGS-G	N	WGS-84 GRS 80 spheroid, global coverage (WGS84)
 NX NY NZ	Meteorological grid: No. X grid cells in meteorological grid No. Y grid cells in meteorological grid No. vertical layers in meteorological grid	 366 234 10	n/a	
DGRIDKM	Grid spacing (km)	6	n/a	
ZFACE	Cell face heights (m)	0, 20, 40,80, 160, 320, 640, 1200,	n/a	

Variable	Description	Value	Default	Comments
		2000, 3000, 4000		
XORIGKM YORIGKM	Reference coordinates of SW corner of grid cell (1,1) (km)	-1008 -864	n/a	
 IBCOMP JBCOMP IECOMP JECOMP	Computational grid: X index of LL corner Y index of LL corner X index of UR corner Y index of UR corner	 1 1 366 234	n/a	
LSAMP IBSAMP JBSAMP IESAMP JESAMP MESHDN	Logical flag indicating if gridded receptors are used X index of LL corner Y index of LL corner X index of UR corner Y index of UR corner Nesting factor of the sampling grid	F 1	- Y	Receptors are only in the Class I areas assessed
INPUT GROUP 5: Output options				
SPECIES	Species (or group) list for output options	1	n/a	Concentrations saved for SO2, SO4, NOx, HNO3, NO3, PM25, PM10
INPUT GROUP 6: Subgrid scale complex terrain (CTSG) inputs				
NHILL	Number of terrain features	0	Y	
NCTREC	Number of special complex terrain receptors	0	Y	
MHILL	Terrain and CTSG receptor data for CTSG hills input in CTDM format?	2	n/a	Hill data created by OPTHILL & input below in subgroup (6b); receptor data in subgroup (6c) note: no data provided
XHILL2M	Factor to convert horizontal dimensions to meters	1	Y	
ZHILL2M	Factor to convert vertical dimensions to meters	1	Y	
XCTDMKM	X-origin of CTDM system relative to CALPUFF coordinate system, in Km	0	n/a	
YCTDMKM	Y-origin of CTDM system relative to CALPUFF coordinate system, in Km	0	n/a	
INPUT GROUP 7: Chemical parameters for dry deposition of gases				
SPECIES DIFFUSVTY ALPHA STR REACTVTY MESO RES HENRYS C	Chemical parameters for dry deposition of gases	-	Y Y Y Y Y Y	SO2; NOx; HNO3 0.1509 0.1656 0.1628 1000 1 1 8 8 18 0 5 0 0.04 3.5 8.0*E-8
INPUT GROUP 8: Size parameters for dry deposition of particles				
SPECIES GEO. MASS MEAN DIA.	Single species: mean and standard deviation used to compute deposition velocity for	-	n/a	SO4 NO3 PM25 PM10 0.48 0.48 0.48 0.48

Variable	Description	Value	Default	Comments
GEO.STAND DEV.	NINT size-ranges; averaged to obtain mean deposition velocity. Grouped species: size distribution specified, standard deviation as "0". Model uses deposition velocity for stated mean diameter.			2 2 2 2
INPUT GROUP 9: Miscellaneous dry deposition parameters				
RCUTR	Reference cuticle resistance	30	Y	
RGR	Reference ground resistance	10	Y	
REACTR	Reference pollutant reactivity	8	Y	
NINT	Number of particle-size intervals to evaluate effective particle deposition velocity	9	Y	
IVEG	Vegetation state in unirrigated areas	1	Y	
INPUT GROUP 10: Wet deposition parameters				
POLL LIQ PRECIP FRZ PRECIP	Scavenging coefficients	-	Y Y Y	SO2 SO4 NOx HNO3 NO3 3E-5 1E-4 0 6E-5 1E-4 0 3E-5 0 0 3E-5
INPUT GROUP 11: Chemistry parameters				
MOZ	Ozone data input option	1	N	Read hourly ozone conc. From the OZONE.DAT data file
BCKO3	Monthly ozone concentrations	-	N	12*40
BCKNH3	Monthly ammonia concentrations	-	N	12*3
RNITE1	Nighttime SO2 loss rate	0.2	Y	
RNITE2	Nighttime NOx loss rate	2.0	Y	
RNITE3	Nighttime HNO3 formation rate	2.0	Y	
MH2O2	H2O2 data input option	1	Y	
BCKH2O2	Monthly H2O2 concentrations	-	Y	MQACHEM = 0; not used
BCKPMF OFRAC VCNX	Secondary Organic Aerosol options	-	-	MCHEM = 1; thus, not used
INPUT GROUP 12: Misc. Dispersion and computational parameters				
SYTDEP	Horizontal size of puff beyond which time-dependent dispersion equations (Heffter) are used.	550	Y	
MHFTSZ	Switch for using Heffter equation for sigma z as above	0	Y	
JSUP	Stability class used to determine plume growth rates for puffs above boundary layer	5	Y	
CONK1	Vertical dispersion constant for stable conditions	0.01	Y	
CONK2	Vertical dispersion constant for neutral/unstable conditions	0.1	Y	
TBD	Factor determining transition-point from Schulman-Scire to	0.5	Y	No building downwash used

Variable	Description	Value	Default	Comments
	Huber-Snyder building downwash scheme			
IURB1 IURB2	Range of land use categories for which urban dispersion is assumed	10 19	Y Y	METFM=1; not used
ILANDUIN	Land use category for modeling domain	-	-	METFM=1; not used
ZOIN	Roughness length (m) for modeling domain	-	-	METFM=1; not used
XLAIIN	Leaf area index for modeling domain	-	-	METFM=1; not used
ELEVIN	Elevation above sea level	-	-	METFM=1; not used
XLATIN	Latitude (degrees) for met location	-	-	METFM=1; not used
XLONIN	Longitude (degrees) for met location	-	-	METFM=1; not used
ANEMHT	Anemometer height (m)	-	-	METFM=1; not used
ISIGMAV	Form of lateral turbulence data in PROFILE.DAT	1	Y	Read sigma-v
IMIXCTDM	Choice of mixing heights	-	-	METFM=1; not used
XMXLEN	Maximum length of a slug	1	Y	
XSAMLEN	Maximum travel distance of a puff/slug during one sampling step	1	Y	
MXNEW	Maximum number of slugs/puffs released from one source during one time step	99	Y	
MXSAM	Maximum number of sampling steps for one puff/slug during one time step	99	Y	
NCOUNT	Number of iterations used when computing the transport wind for a sampling step that includes gradual rise	2	Y	
SYMIN	Minimum sigma y for a new puff/slug	1	Y	
SZMIN	Minimum sigma z for a new puff/slug	1	Y	
 SVMIN SWMIN	Default minimum turbulence velocities sigma-v and sigma-w for each stability class	-	Y	A B C D E F .5 .5 .5 .5 .5 .5 .2 .12 .08 .06 .03 .016
CDIV	Divergence criterion for dw/dz across puff used to initiate adjustment for horizontal convergence	0, 0	Y	
WSCALM	Minimum wind speed allowed for non-calm conditions. Used as minimum speed returned when using power-law extrapolation toward surface	0.5	Y	
XMAXZI	Maximum mixing height (m)	4000	N	Top interface in CALMET simulation
XMINZI	Minimum mixing height (m)	20	N	
	Default wind speed classes	-	Y	1 2 3 4 5

Variable	Description	Value	Default	Comments
WSCAT				1.54 3.09 5.14 8.23 10.80
PLXO	Default wind speed profile power-law exponents for stabilities 1-6	-	Y ISC RURAL	A B C D E F .07 .07 .10 .15 .35 .55
PTGO	Default potential temperature gradient for stable classes E, F (deg K/m)	-	Y	0.020; 0.035
PPC	Default plume path coefficients for each stability class	-	Y	A B C D E F .5 .5 .5 .5 .35 .35
SL2PF	Slug-to-puff transitions criterion factor equal to sigma-y/length of slug	10	Y	
NSPLIT	Number of puffs that result every time a puff is split	3	Y	
IRESPLIT	Time of day when split puffs are eligible to be split once again; this is typically set once per day, around sunset before nocturnal shear develops	-	N	Hour 18 = 1
ZISPLIT	Split is allowed only if last hour's mixing height (m) exceeds a minimum value	100	Y	
ROLDMAX	Split is allowed only if ratio of last hour's mixing ht to the maximum mixing ht experienced by the puff is less than a maximum value	0.25	Y	
NSPLITH	Number of puffs that result every time a puff is split	5	Y	
SYSPLITH	Minimum sigma-y of puff before it may be split	1	Y	
SHSPLITH	Minimum puff elongation rate due to wind shear, before it may be split	2	Y	
CNSPLITH	Minimum concentration of each species in puff before it may be split	1E-7	Y	
EPSSLUG	Fractional convergence criterion for numerical SLUG sampling integration	1E-4	Y	
EPSAREA	Fractional convergence criterion for numerical AREA source integration	1E-6	Y	
DSRISE	Trajectory step-length (m) used for numerical rise integration	1	Y	
HTMINBC	Minimum height (m) to which BC puffs are mixed as they are emitted. Actual height is reset to the current mixing height at the release point if greater than this minimum	500	Y	
RSAMPBC	Search radius (in BC segment lengths) about a receptor for sampling nearest BC puff. BC	10	N	

Variable	Description	Value	Default	Comments
	puffs are emitted with a spacing of one segment length, so the search radius should be greater than 1			
MDEPBC	Near-surface depletion adjustment to concentration profile used when sampling BC puffs?	1	Y	Adjust concentration for depletion
INPUT GROUP 13: Point source parameters				
NPT1	Number of point sources with parameters	-	n/a	See Appendix B
IPTU	Units used for point source emissions	1	Y	
NSPT1	Number of source-species combinations with variable emissions scaling factors	0	Y	
NPT2	Number of point sources with variable emission parameters provided in external file	0	n/a	
INPUT GROUP 14: Area source parameters – Not used				
INPUT GROUP 15: Line source parameters – Not used				
INPUT GROUP 16: Volume source parameters – Not used				
INPUT GROUP 17: Non-gridded (discrete) receptor information				
NREC	Number of non-gridded receptors	0 1229	n/a	100 Badlands 80 Caney Creek 195 Great Sand Dunes 80 Hercules-Glades 47 Mingo 407 Rocky Mountain 72 Upper Buffalo 189 Wind Cave 59 Wichita Mountains

Appendix E – POSTUTIL Control File Inputs

Variable	Description	Value	Default	Comments
INPUT GROUP 1: General run control parameters				
ISYR	Starting Year	2002	n/a	2001 and 2003 also modeled
ISMO	Starting month	1	n/a	
IDY	Starting day	1	n/a	
ISHR	Starting hour	1	n/a	
NPER	Number of periods to process	8760	n/a	2001=8760 hrs, 2003=8748hrs only 12 hrs on 12/31
NSPECINP	Number of species to process from CALPUFF runs	7	n/a	
NSPECOUT	Number of species to write to output file	7	n/a	
NSPECCMP	Number of species to compute from those modeled	0	n/a	
MDUPLCT	Stop run if duplicate species names found?	0	Y	
NSCALED	Number of CALPUFF data files that will be scaled	0	Y	
MNITRATE	Re-compute the HNO3/NO3 partition for concentrations?	1	N	Yes, for all sources combined
BCKNH3	Default ammonia concentrations used for HNO3/NO3 partition	-	N	12*3
INPUT GROUP 2: Species processing information				
ASPECI	NSPECINP species will be processed	-	n/a	SO2, SO4, NOx, HNO3, NO3, PMC, PMF
ASPECO	NSPECOUT species will be written	-	n/a	SO2, SO4, NOx, HNO3, NO3, PMC, PMF

Appendix F – CALPOST Control File Inputs

Variable	Description	Value	Default	Comments
INPUT GROUP 1: General run control parameters				
METRUN	Option to run all periods found in met files	0	Y	Run period explicitly defined
ISYR	Starting Year	2002	n/a	2001 and 2003 also modeled
ISMO	Starting month	1	n/a	
IDY	Starting day	1	n/a	
ISHR	Starting hour	1	n/a	
NHRS	Number of hours to process	8760	n/a	2001=8760hrs, 2003=8748hrs only 12 hrs on 12/31
NREP	Process every hour of data?	1	Y	Every hour processed
ASPEC	Species to process	VISIB	n/a	Visibility processing
ILAYER	Layer/deposition code	1	Y	CALPUFF concentrations
A, B	Scaling factors X(new) = X(old) *A + B	0, 0	Y	
LBACK	Add hourly background concentrations/fluxes?	F	Y	
MSOURCE	Option to process source contributions	0	Y	
LG LD	Gridded receptors processed? Discrete receptors processed?	F T	N/Y	Receptors located only in the Class I areas assessed
LCT	CTSG Complex terrain receptors processed?	F	Y	
LDRING	Report results by DISCRETE receptor RING?	F	Y	
NDRECP	Flag for all receptors after the last one assigned is set to "0"	-1	Y	
IBGRID JBGRID IEGRID JEGRID	Range of gridded receptors	-1 -1 -1 -1	Y	When LG = T Entire grid processed if all =-1
NGONOFF	Number of gridded receptor rows provided to identify specific gridded receptors to process	0	Y	
BTZONE	Base time zone for the CALPUFF simulation	6	n/a	
MFRH	Particle growth curve f(RH) for hygroscopic species	2	Y	FLAG (2000) f(RH) tabulation. Note: not used
RHMAX	Maximum relative humidity (%) used in particle growth curve	-	N	Not used
LVSO4 LVNO3 LVOC LVPMC LVPMF LVEC	Modeled species to be included in computing light extinction	T T F T T F	Y Y N Y Y N	
LVBK	Include BACKGROUND when ranking for TOP-N, TOP-50, and exceedence tables?	T	Y	
SPECPMC	Species name used for particulates in	PMC	Y	

Variable	Description	Value	Default	Comments
SPECPMF	MODEL.DAT file	PMF	Y	
EEPMC EEPMF	Modeled particulate species	0.6 1.0	Y Y	
EEPMCBK	Background particulate species	0.6	Y	
EESO4 EENO3 EEOC EESOIL EEEC	Other species	3.0 3.0 4.0 1.0 10	Y Y Y Y Y	
LAVER	Background extinction computation	F	Y	
MVISBK	Method used for background light extinction	6	N	Compute extinction from speciated PM measurements. FLAG RH adjustment factor applied to observed and modeled sulfate and nitrate
RHFAC	Extinction coefficients for hygroscopic species (modeled and background). Monthly RH adjustment factors	-	n/a	See Table 5 in main protocol document
BKSO4 BKNO3 BKPMC BKOC BKSOIL BKEC	Monthly concentrations of ammonium sulfate, ammonium nitrate, coarse particulates, organic carbon, soil and elemental carbon to compute background extinction coefficients	-	n/a	See Table 6 in main protocol document
BEXTRAY	Extinction due to Rayleigh scattering (1/Mm)	10	Y	
IPRTU	Units for all output	1	Y	grams/cubic meter
L24HR	Averaging time reported	T	n/a	
LTOPN	Visibility: Top "N" table for each averaging time selected.	F	Y	
NTOP	Number of 'Top-N' values at each receptor selected (NTOP must be <=4)	4	Y	
MDVIS	Output file with visibility change at each receptor?	0	Y	Create file of DAILY (24 hour) delta-deciview. Grid model run.

Appendix E – CALPUFF Comparison – Regulatory vs. Proposed

The regulatory version of CALPUFF is Version: 5.7, Level: 030402. The KDHE is proposing to use Version: 5.753, Level: 051130. The regulatory version of CALPOST is CALPOST Version 5.4, Level 030402. The KDHE is proposing to use Version 5.6392, Level 051130.

To ensure our proposed version of the models would not lead to differences in results we ran one source using both versions of the models for 1 year and evaluated deciview impacts in all 9 Class I areas. The resulting number of deciview impacts > 0.5 was the same at all Class I areas. In addition, the daily impacts were also identical.

The two tables below show the number of impacts > 0.5 dv and the daily comparison of visibility impacts, in delta dv for one of the Class I areas.

Class I Area	DV > 0.5 Regulatory	DV > 0.5 Proposed
Badlands	1	1
Caney Creek	10	10
Great Sand Dunes	0	0
Hercules-Glades	8	8
Mingo	5	5
Rocky Mountain	0	0
Upper Buffalo	8	8
Wichita Mountains	2	2
Wind Cave	1	1

Comparison of the daily delta deciview impacts in Caney Creek in 2003 using both the regulatory and proposed version of CALPUFF and CALPOST.

Year	Day	Regulatory	Proposed
2003	1	0	0
2003	2	0.067	0.067
2003	3	0.002	0.002
2003	4	0	0
2003	5	0	0
2003	6	0.023	0.023
2003	7	0.058	0.058
2003	8	0.007	0.007
2003	9	0.002	0.002
2003	10	0.012	0.012
2003	11	0.005	0.005
2003	12	0.034	0.034
2003	13	0.044	0.044
2003	14	0.066	0.066
2003	15	0.828	0.828
2003	16	0.303	0.303
2003	17	0.047	0.047

2003	18	0	0
2003	19	0	0
2003	20	0	0
2003	21	0.084	0.084
2003	22	0.048	0.048
2003	23	0.134	0.134
2003	24	0.006	0.006
2003	25	0.008	0.008
2003	26	0.085	0.085
2003	27	0.388	0.388
2003	28	0.02	0.02
2003	29	0.163	0.163
2003	30	0.122	0.122
2003	31	0.067	0.067
2003	32	0	0
2003	33	0	0
2003	34	0.113	0.113
2003	35	0.019	0.019
2003	36	0.058	0.058
2003	37	0.053	0.053
2003	38	0.326	0.326
2003	39	0.037	0.037
2003	40	0.026	0.026
2003	41	0	0
2003	42	0	0
2003	43	0.001	0.001
2003	44	0	0
2003	45	0	0
2003	46	0.694	0.694
2003	47	0.044	0.044
2003	48	0.001	0.001
2003	49	0.032	0.032
2003	50	0.002	0.002
2003	51	0.007	0.007
2003	52	0.006	0.006
2003	53	0.296	0.296
2003	54	0.251	0.251
2003	55	0.349	0.349
2003	56	0.216	0.216
2003	57	0.003	0.003
2003	58	0.033	0.033
2003	59	0.117	0.117
2003	60	0.122	0.122
2003	61	0.239	0.239
2003	62	0.602	0.602
2003	63	0.756	0.756
2003	64	1.008	1.008
2003	65	0.405	0.405
2003	66	0.088	0.088
2003	67	0.016	0.016

2003	68	0.289	0.289
2003	69	0.38	0.38
2003	70	0.203	0.203
2003	71	0.013	0.013
2003	72	0.021	0.021
2003	73	0.606	0.606
2003	74	0.351	0.351
2003	75	0.083	0.083
2003	76	0.012	0.012
2003	77	0.002	0.002
2003	78	0	0
2003	79	0.142	0.142
2003	80	0.006	0.006
2003	81	0.055	0.055
2003	82	0.009	0.009
2003	83	0.003	0.003
2003	84	0.004	0.004
2003	85	0.057	0.057
2003	86	0.016	0.016
2003	87	0.062	0.062
2003	88	0	0
2003	89	0	0
2003	90	0	0
2003	91	0	0
2003	92	0	0
2003	93	0	0
2003	94	0.001	0.001
2003	95	0.108	0.108
2003	96	0.067	0.067
2003	97	0.084	0.084
2003	98	0.104	0.104
2003	99	0.175	0.175
2003	100	0.004	0.004
2003	101	0.022	0.022
2003	102	0.027	0.027
2003	103	0.016	0.016
2003	104	0.003	0.003
2003	105	0	0
2003	106	0	0
2003	107	0.016	0.016
2003	108	0.021	0.021
2003	109	0	0
2003	110	0.074	0.074
2003	111	0.023	0.023
2003	112	0.01	0.01
2003	113	0.039	0.039
2003	114	0	0
2003	115	0.153	0.153
2003	116	0.069	0.069
2003	117	0.036	0.036

2003	118	0.003	0.003
2003	119	0	0
2003	120	0	0
2003	121	0	0
2003	122	0.023	0.023
2003	123	0.167	0.167
2003	124	0.038	0.038
2003	125	0	0
2003	126	0	0
2003	127	0.002	0.002
2003	128	0.003	0.003
2003	129	0	0
2003	130	0	0
2003	131	0.004	0.004
2003	132	0	0
2003	133	0	0
2003	134	0	0
2003	135	0	0
2003	136	0	0
2003	137	0.002	0.002
2003	138	0.094	0.094
2003	139	0.024	0.024
2003	140	0.065	0.065
2003	141	0.14	0.14
2003	142	0.028	0.028
2003	143	0.014	0.014
2003	144	0.01	0.01
2003	145	0.36	0.36
2003	146	0.545	0.545
2003	147	0.09	0.09
2003	148	0.045	0.045
2003	149	0.176	0.176
2003	150	0.057	0.057
2003	151	0.09	0.09
2003	152	0.068	0.068
2003	153	0.042	0.042
2003	154	0.433	0.433
2003	155	0.372	0.372
2003	156	0.108	0.108
2003	157	0.063	0.063
2003	158	0.095	0.095
2003	159	0.033	0.033
2003	160	0.013	0.013
2003	161	0.004	0.004
2003	162	0.001	0.001
2003	163	0.001	0.001
2003	164	0.002	0.002
2003	165	0.016	0.016
2003	166	0.052	0.052
2003	167	0.077	0.077

2003	168	0.024	0.024
2003	169	0.009	0.009
2003	170	0.02	0.02
2003	171	0.017	0.017
2003	172	0	0
2003	173	0	0
2003	174	0	0
2003	175	0	0
2003	176	0	0
2003	177	0.024	0.024
2003	178	0.092	0.092
2003	179	0	0
2003	180	0.002	0.002
2003	181	0.004	0.004
2003	182	0.004	0.004
2003	183	0.004	0.004
2003	184	0.002	0.002
2003	185	0.001	0.001
2003	186	0	0
2003	187	0	0
2003	188	0	0
2003	189	0	0
2003	190	0	0
2003	191	0	0
2003	192	0.04	0.04
2003	193	0.03	0.03
2003	194	0.002	0.002
2003	195	0	0
2003	196	0	0
2003	197	0	0
2003	198	0.001	0.001
2003	199	0.001	0.001
2003	200	0	0
2003	201	0	0
2003	202	0.016	0.016
2003	203	0.04	0.04
2003	204	0.027	0.027
2003	205	0.001	0.001
2003	206	0	0
2003	207	0	0
2003	208	0	0
2003	209	0	0
2003	210	0	0
2003	211	0.017	0.017
2003	212	0.086	0.086
2003	213	0.098	0.098
2003	214	0.047	0.047
2003	215	0.006	0.006
2003	216	0	0
2003	217	0	0

2003	218	0.093	0.093
2003	219	0.46	0.46
2003	220	0.216	0.216
2003	221	0.036	0.036
2003	222	0.006	0.006
2003	223	0.051	0.051
2003	224	0.005	0.005
2003	225	0	0
2003	226	0	0
2003	227	0	0
2003	228	0	0
2003	229	0.001	0.001
2003	230	0.001	0.001
2003	231	0.01	0.01
2003	232	0.027	0.027
2003	233	0.034	0.034
2003	234	0.036	0.036
2003	235	0.064	0.064
2003	236	0.136	0.136
2003	237	0.161	0.161
2003	238	0.121	0.121
2003	239	0.039	0.039
2003	240	0.017	0.017
2003	241	0.002	0.002
2003	242	0	0
2003	243	0	0
2003	244	0.002	0.002
2003	245	0.031	0.031
2003	246	0.083	0.083
2003	247	0.052	0.052
2003	248	0.001	0.001
2003	249	0	0
2003	250	0	0
2003	251	0	0
2003	252	0	0
2003	253	0	0
2003	254	0	0
2003	255	0	0
2003	256	0	0
2003	257	0.636	0.636
2003	258	0.186	0.186
2003	259	0.021	0.021
2003	260	0	0
2003	261	0	0
2003	262	0.046	0.046
2003	263	0.016	0.016
2003	264	0.066	0.066
2003	265	0.041	0.041
2003	266	0.003	0.003
2003	267	0.012	0.012

2003	268	0.054	0.054
2003	269	0.057	0.057
2003	270	0.025	0.025
2003	271	0.018	0.018
2003	272	0.014	0.014
2003	273	0.001	0.001
2003	274	0.051	0.051
2003	275	0.154	0.154
2003	276	0.115	0.115
2003	277	0.07	0.07
2003	278	0.078	0.078
2003	279	0.078	0.078
2003	280	0.069	0.069
2003	281	0.046	0.046
2003	282	0.013	0.013
2003	283	0.004	0.004
2003	284	0	0
2003	285	0.066	0.066
2003	286	0.149	0.149
2003	287	0.071	0.071
2003	288	0.045	0.045
2003	289	0.015	0.015
2003	290	0.015	0.015
2003	291	0.01	0.01
2003	292	0.034	0.034
2003	293	0.01	0.01
2003	294	0	0
2003	295	0.128	0.128
2003	296	0.106	0.106
2003	297	0.011	0.011
2003	298	0.088	0.088
2003	299	0.125	0.125
2003	300	0.037	0.037
2003	301	0	0
2003	302	0	0
2003	303	0	0
2003	304	0	0
2003	305	0.001	0.001
2003	306	0	0
2003	307	0	0
2003	308	0.018	0.018
2003	309	0.888	0.888
2003	310	1.185	1.185
2003	311	0.295	0.295
2003	312	0.015	0.015
2003	313	0	0
2003	314	0	0
2003	315	0	0
2003	316	0	0
2003	317	0.005	0.005

2003	318	0	0
2003	319	0	0
2003	320	0	0
2003	321	0	0
2003	322	0.004	0.004
2003	323	0.157	0.157
2003	324	0	0
2003	325	0	0
2003	326	0	0
2003	327	0.001	0.001
2003	328	0	0
2003	329	0	0
2003	330	0	0
2003	331	0.162	0.162
2003	332	0.07	0.07
2003	333	0	0
2003	334	0	0
2003	335	0.044	0.044
2003	336	0	0
2003	337	0.006	0.006
2003	338	0.108	0.108
2003	339	0.362	0.362
2003	340	0.036	0.036
2003	341	0	0
2003	342	0	0
2003	343	0.002	0.002
2003	344	0.252	0.252
2003	345	0.004	0.004
2003	346	0.123	0.123
2003	347	0.005	0.005
2003	348	0.091	0.091
2003	349	0.013	0.013
2003	350	0.001	0.001
2003	351	0	0
2003	352	0	0
2003	353	0	0
2003	354	0	0
2003	355	0.002	0.002
2003	356	0	0
2003	357	0.063	0.063
2003	358	0.034	0.034
2003	359	0.119	0.119
2003	360	0.019	0.019
2003	361	0	0
2003	362	0	0
2003	363	0	0
2003	364	0	0